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(57) Abstract

The invention relates to compositions that can be isolated from *Lepidium* plant material and to methods for their isolation. The compositions are useful for treating and preventing cancer and sexual dysfunction.

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COMPOSITIONS AND METHODS FOR THEIR PREPARATION FROM *LEPIDIUM*.

The present invention relates to compositions containing particular components that can be obtained from a plant which can have pharmaceutical applications. More particularly, the plant genus is *Lepidium*.

Lepidium meyenii, commonly called maca or Peruvian ginseng, is a perennial plant having a fleshy, edible, tuberous root. Another species is *Lepidium peruvianum*. The maca root is consumed for food and is also consumed for its pharmacological properties; for example to enhance fertility. (*See* Leon, J., Economic Botany, 18:122-127(1964)) Maca has also been used to treat chronic fatigue. (Steinberg, P., Phil Steinberg's Cat's Claw News, Vol. 1, Issue 2, July/August (1995).

Johns, *Ethnobiology*, 1:208-212(1981), studied the biologically active aromatic glycosinolates present in the plant and also reported that benzyl isothiocyanate was the principal isothiocyanate in the plant, with p-methoxybenzyl isothiocyanate being present in relatively smaller amount. The role of these species in reproduction was discussed.

Dini et al., *Food Chem.*, 49:347-349(1994) described the total content of carbohydrates and amino acids (free and from protein hydrolysis) and listed 20 saturated and unsaturated paraffinic acids (principally linoleic, palmitic, and oleic acids) present in the plant. A sterol fraction containing five sterols (identified as their acetates) was also reported. An alkaloid fraction was reported but not characterized.

SUMMARY OF THE INVENTION

In one aspect, the present invention relates to an isolated, *Lepidium*-derived composition that is essentially free of cellulose and lignin and that has about 40% of polysaccharides that can be isolated from *Lepidium* plant material (a *Lepidium* polysaccharide component). The composition can also contain an aqueous component and a component, designated a *Lepidium* amino acid component, having amino acids that can be isolated from *Lepidium* plant material and. Typically, the *Lepidium* amino acid component has about 70% or more proline, 5% or more glutamic acid, and 5% or more valine. In certain embodiments, the composition has about 0.3% benzyl isothiocyante and about 0.5% of a component, called a *macamide* component, having amides of fatty acids that can be isolated from *Lepidium* material. In an particular embodiment, the composition has about 45% or more of a *Lepidium* polysaccharide component. In another embodiment, the composition is combined with one or more pharmaceutically acceptable excipients.

In another aspect, the present invention relates to a composition having about 0.3% or more benzyl isothiocyanate, about 0.3% or more of a *macamide* component, about 1% or more of fatty acids that can be isolated from *Lepidium* plant material (a *Lepidium* fatty acid component), and about 0.15% of sterols that can be isolated from *Lepidium* plant material (a *Lepidium* sterol component). In a preferred embodiment, the composition has between about 2% and about 5% benzyl isothiocyanate, about 0.2% and about 1% *Lepidium* sterol component, between about 10% and about 20% *Lepidium* fatty acid component, and about 3% to about 7% *macamide* component. In a particularly preferred embodiment, the composition has between about 5% and about 9% benzyl isothiocyanate, between about 1% and about 3% of *Lepidium* sterol component, between about 20% and about 30% of a *Lepidium* fatty acid component, and about 10% or more of *macamide* component. One or more of the foregoing compositions can be combined with a pharmaceutically acceptable excipient.

In another aspect, the invention relates to novel fatty acid amides: N-benzyl-octanamide having the chemical formula $C_{15}H_{23}NO$, N-benzyl-16(*R,S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrieneamide having chemical formula $C_{25}H_{35}NO_3$, and N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrieneamide having the chemical formula $C_{25}H_{35}NO_3$.

In yet another embodiment, the present invention relates to a process of obtaining an isolated *Lepidium* -derived composition including the steps of:

a) contacting *Lepidium* plant material with an aqueous solvent,

b) separating the contacted aqueous solvent from the *Lepidium* plant material, and

c) concentrating the composition of step b) to isolate the composition.

Preferably, the aqueous solvent is water. More preferably, the aqueous solvent is a mixture of alcohol, preferably SDA, and still more preferably, a mixture of 75 vol-% SDA and 25 vol-% water.

In yet other embodiments, the process includes the further steps of:

d) applying the first *Lepidium* composition from step c) to a reverse phase liquid chromatography column,

f) eluting the reverse phase chromatography column with a first elution volume of aqueous solvent effective to elute a first effluent from which a composition having about 45% or more *Lepidium* polysaccharide component is isolated by, for example, concentration.

In yet another embodiment, the invention process includes the further step of g), eluting the reverse phase chromatography column with a second elution volume of

aqueous solvent to form a second effluent from which the composition can be isolated by, for example, the step of concentrating the second effluent.

In a preferred embodiment, the second elution volume has two or more gradient volumes that are sequentially eluted and the resulting second effluent is fractionate collected as gradient fractions so that at least one gradient fraction is collected for each gradient volume eluted. The gradient fractions can be combined and concentrated to obtain an isolated *Lepidium* derived composition that has about 0.3% or more of benzyl isothiocyanate, about 0.15% or more *Lepidium* sterol component, about 1% or more *Lepidium* fatty acid component, and about 0.3% or more of *macamide* component. Preferrably, each of the two or more gradient volumes comprises a mixture of an alcohol and water and wherein the vol-% alcohol in the first gradient volume is about 20 vol-% or more and the vol-% alcohol in any subsequent gradient volume is equal to or greater than the vol-% alcohol in the immediately previously eluted gradient volume.

In yet another embodiment, the invention provides a process for producing the composition having between about 5% and about 9% of benzyl isothiocyanate, between about 1% and about 3% of *Lepidium* sterol component, between about 20% and about 30% of *Lepidium* fatty acid component, and d) about 10% or more of *macamide* component comprising the steps of:

a) contacting *Lepidium* plant material with an aqueous solvent comprising about 90 vol-% or more water,

c) concentrating the contacted aqueous solvent to make a residue of *Lepidium* plant material,

d) contacting the residue of *Lepidium* plant material with aqueous solvent comprising a mixture of an alcohol and water having about 90 vol-% alcohol or more to form a liquor, and

e) concentrating the liquor to obtain the composition.

The preferred plant material in any embodiment is *Lepidium meyenii*.

In still another embodiment, the present invention relates to a method of treating or preventing cancer in an animal, preferably a human, by administering a cancer treating or preventing effective amount of any of the hereinabove described isolated *Lepidium* -derived compositions. In another embodiment, the present invention relates to a method for treating sexual dysfunction in an animal, preferably a human, by administering a sexual dysfunction treating or preventing amount of any of the hereinabove described isolated *Lepidium*-derived compositions to the animal. In a preferred embodiment, the animal is a female animal and the sexual dysfunction is infertility. In a more preferred embodiment, the animal is a male animal

and the sexual dysfunction is a sub-normal libido. In a yet more preferred embodiment, the animal is a male animal and the sexual dysfunction is impotence.

DETAILED DESCRIPTION

As used herein, the following terms have the following meanings.

Alcohol: The term alcohol refers to a lower aliphatic alcohol having from one to six carbon atoms.

Aqueous component: This term refers to that part or portion of a composition that is made-up of one or more aqueous solvents.

Aqueous solvent: The term aqueous solvent means water or a single phase having an organic solvent that is miscible with water. Examples of miscible organic solvents include but are not limited to methanol, ethanol, isopropanol, n-propanol, acetone, and acetonitrile. Other miscible organic solvents are known to the skilled artesian.

Benzyl isothiocyante: includes benzyl isothiocynate and its methoxy derivatives.

Column volume: Column volume refers to the volume of the space defined by the inner surface of the chromatography column or chamber that surrounds the stationary phase or a reverse phase chromatography column. Column volume is abbreviated herein as CV.

Fractionate collecting: When used in connection with an effluent or a gradient effluent, or a gradient fraction, the term fractionate collecting denotes that the effluent or gradient effluent is segregated into at least two portions or aliquots.

Lepidium amino acid component: This term refers to that part or portion of a composition that is made-up of amino acids that can be isolated from *Lepidium* plant material.

Lepidium composition: A *Lepidium* composition is a composition having at least one of a *Lepidium* amino acid component, a *Lepidium* fatty acid component, a *Lepidium* polysaccharide component, or a *macamide* component.

Lepidium fatty acid component: This term refers to that part or portion of a composition that is made-up of fatty acids that can be isolated from *Lepidium* plant material.

Lepidium plant material: As used herein, *Lepidium* plant material refers to plant matter from any part of a plant of the genus *Lepidium*. Examples of *Lepidium* plant matter include, but are not limited to, matter from *Lepidium meyenii* and *Lepidium peruvianum*.

Lepidium polysaccharide component: This term denotes that part or portion of a composition that is made-up of polysaccharides that can be isolated from *Lepidium* plant material.

Lepidium sterol component: As used herein, the term refers to that part or portion of a composition that is made-up of sterols that can be isolated from *Lepidium* plant material.

Macamide: Means amides and N-substituted amides of fatty acids that can be isolated from *Lepidium* plant material.

Percent (%): Unless otherwise limited or modified, percents and percentages described herein are on a weight basis. The chemical composition of plant material from a particular plant species varies with, for example, the conditions under which the plant is grown (for example soil and climate). A particular compound or mixture of compounds can exhibit pharmacological efficacy over a readily ascertainable range of composition and dosage. Therefore, it is understood that the percentages recited throughout are meant to include such variations outside the stated percentage or percentage ranges as would be anticipated by the skilled artesian.

Substantially Free of cellulose: Means having 5% or less of cellulose and lignin combined.

SDA: Means special denatured alcohol, typically a mixture of 97% to 95% ethanol with 3% to 5% of methanol or coal tar.

First *Lepidium* compositions of the invention can be obtained from an extraction composition in a first process. Starting material for a first process is *Lepidium* plant material, preferably *Lepidium meyenii*. *Lepidium* plant material, for example the root of *Lepidium* meyenii, is reduced in size to pieces having nominal dimensions between about 0.1 mm and 30 mm. The pieces of *Lepidium* plant material are contacted with aqueous solvent. The contacting in this or any embodiment may be by any suitable means as are known in the art; for example, percolation, vat extraction, counter current extraction, and the like. The contacting is for a time from about 2 hr. to about 18 hr. The contacting is carried out at a temperature above the solidification temperature (or where applicable the phase separation temperature) but below the boiling point of the aqueous solvent. Typically, the contacting is conducted from 20°C to 75°C, with 40°C to 50°C being preferred. After the contacting, the aqueous solvent, which is an extraction composition containing a first *Lepidium* composition, is separated from residual plant

material and the extraction composition is concentrated until the extraction composition has a solids component generally of at least about 70%, of which typically 40% is a *Lepidium* polysaccharide component. In this or any embodiment, the concentration can be by any of the means as are known in the art such as evaporation, distillation, and lyophilization, to mention a few.

First *Lepidium* compositions generally have 30% or more, preferably about 40% or more, of a *Lepidium* polysaccharide component and about 1% or more of a *macamide* component. Typically, 70% or more of the polysaccharide units of a polysaccharide of a *Lepidium* polysaccharide component are sucrose units. A *macamide* component includes N-benzyl octanamide *(macamide A)*, N-benzyl-16-hydroxy-9-oxo-10*E*,12*E*,14*E*-octatrieneamides *(macamide B)*, and N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrieneamide *(macamide C)*. First *Lepidium* compositions further contain about 8% or more of a *Lepidium* amino acid component. The *Lepidium* amino acid component of a first *Lepidium* composition typically has 70% or more proline, 5% or more glutamic acid, and 5% or more valine. First *Lepidium* compositions also generally contain up to 1% of benzyl isothiocyanate. First *Lepidium* compositions can also contain about 0.5% to about 1.5% *Lepidium* fatty acid component. First *Lepidium* compositions of the present invention are useful for their nutritional value and are useful for the treatment or prophylaxis of carcinomas. First *Lepidium* compositions are also useful for treating sexual dysfunction in particular sub-normal libido and impotence in males and infertility in women.

In a first process of the present invention, the composition of the extraction composition and the composition of the first *Lepidium* composition obtained therefrom can be changed by changing the aqueous solvent. When the aqueous solvent is an alcohol-water mixture having 75 vol-% SDA, the first *Lepidium* composition generally contains about 0.8% or more benzyl isothiocyanate and a *Lepidium* fatty acid component of about 1% or more. When the aqueous solvent is 90 vol-% or more water, the first *Lepidium* composition has less than about 0.1% of benzyl isothiocyanate and less than about 2% *Lepidium* fatty acid component.

In a preferred embodiment, a first *Lepidium* composition having a *Lepidium* polysaccharide component of about 45% or more, a *Lepidium* fatty acid component between about 1% and about 2%, and less than about 1% each *Lepidium* sterol component and benzyl isothiocyanate is obtained by a suitably adapted first process that includes a reverse phase liquid chromatography process adapted to elute a first effluent containing a first *Lepidium* composition. In reverse phase liquid chromatography (RPLC), the column packing (stationary phase, or

adsorbent) is non-polar, typically having a dipole moment of about 3 or less. Silica gel that has been treated to provide it with a bonded surface layer that is paraffinic in nature is an example of a useful stationary phase for reverse phase chromatography. Silica gels having permanently bonded C_8 to C_{18} alkyl groups are commercially available as a stationary phase. For example, WP-Octadecyl from J.T. Baker Corp,, Phillipsburg, NJ, 08865. Reverse phase liquid chromatography columns are eluted with eluents of decreasing polarity which causes the more polar compounds loaded on a column to elute first.

Reverse phase liquid chromatography stationary phases of organic material are also known. Polymers of vinyl aromatic compounds, for example styrene, that are crosslinked with polyvinylic aromatic hydrocarbons, for example divinyl benzene, can be used as stationary phases for reverse phase liquid chromatography. These organic polymeric stationary phases are made by processes that yield small, extremely rigid, macroreticular particles. Crosslinked acrylic polymers are also useful as stationary phases for reverse phase liquid chromatography, as are polyvinyl alcohols (alkylated or non-alkylated). Suitable stationary organic phases for RPLC are commercially available. For example, styrenic and acrylic stationary phases are available from the Rohm and Haas Company, Philadelphia, PA, under the trade name Amberlite®. Styreneic stationary phases are also available under the trade name Amberchrom® from Tossohass, Montgomeryville, PA. Polyamide resins (e.g. nylons), polyester resins, and phenolic resins are also useful stationary phases for the reverse phase chromatography processes of the present invention.

Many organic solvents are suitable mobile phases, or eluents, for reverse phase liquid chromatography. Lower alcohols, such as methanol, ethanol, and propanol, as well as nitriles such as acetonitrile, are suitable as organic eluents. Lower aliphatic ketones such as acetone, methyl ethyl ketone, and diethyl ketone, as well as cyclic ethers such as tetrahydrofuran, can also be used. Dimethyl formamide, dimethyl sulfoxide, and alkyl esters of acetic acid such as ethyl acetate can also be used. Mixtures of such solvents in various proportions can be used when it is desired to elute or wash the column with solvents of varying polarity. Applicants have found that aqueous solvents that are mixtures of water and an alcohol, for example, methanol, ethanol, n-propanol, iso-propanol, n-butanol, and n-and sec-hexanol, are particularly useful as mobile phases or eluents for the RPLC processes of the present invention, which in certain embodiments are carried out using an eluent of variable composition. Thus, an elution volume which is a volume of aqueous solvent applied to the column, can be a gradient eluent having two or more gradient volumes, the composition of which can be the same or different, or the compositon of the gradient eluent can be varied continuously during elution. The composition of

the elution volume that is a gradient eluent can vary step-wise, linearly, sigmoidally, exponentially, logarithmically, parabolically, or hypyperbolically during elution. The limits of concentration of gradient eluents are determined by the concentration of polar organic solvent necessary to elute products from the stationary phase and by the requirement that the polar organic solvent be miscible to form a single phase at the required concentration.

In certain embodiments of the present invention the initial alcohol concentration in the elution volume is 10 volume percent (10 vol-%) or less and is increased as separation and purification proceeds.

The reverse phase liquid chromatography systems used to practice the present invention may be either preparative or analytical. Preparative columns have larger loading capacity and are typically larger in size.

With regards to the dimensions of the reverse phase liquid chromatographic column, the loading of the column, the temperature, and flow rate, one skilled in the art will know to vary these parameters based primarily upon practical considerations known in the art. For example, flow rates of the eluent are adjusted according to the column dimensions, the degree of separation desired, the particle size of the stationary phase, and the back pressure in the column. The separation is typically carried out at 20°C to 30°C. However, a temperature up to about 45°C can be used. The separation may be carried out at high pressure (500-200 psi) or moderate pressures (100-500 psi) or, preferably, at lower pressures (10-100 psi).

Prior to use, the reverse phase liquid chromatography column can be conditioned by eluting the column with a conditioning volume of a conditioning liquid, preferably an aqueous solvent, more preferably water. The conditioning volume is preferably between about 1 and about 10 column volumes.

The material to be treated is applied to the preferably conditioned reverse phase chromatography column as a solution, a slurry, or a loading concentrate obtained by evaporating an aqueous solvent, preferably alcohol, from an extraction composition containing the product. If the product to be treated is solid, it may be mixed with a suitable solid carrier, for example treated or untreated silica gel, and the solid mixture placed on top of the solid support. Loading of the column is accomplished by eluting the solution, slurry, or loading concentrate through the column; or, when the product to be treated is admixed with silica gel, by eluting the column with a loading elution volume. Preferably, elution of the solution, slurry, loading concentrate, or loading elution volume is followed by elution with a washing elution volume comprising an aqueous solvent having the same composition as the aqueous solvent of the solution, slurry, or

loading concentrate used to load the column stationary phase. The washing elution volume, when one is used, is preferably between about 1 and about 10 column volumes.

Starting material for this adapted first process is a first *Lepidium* composition made by the previously described first process in which the aqueous solvent is an alcohol - water mixture having between about 65 vol-% and about 85 vol-%, preferably about 75 vol-% of alcohol, preferably SDA. The stationary phase of the RPLC column is a styrenic resin, preferably a crosslinked styrene - divinylbenzene resin such as Amberlite® XAD-16HP available from Rohm and Haas. The first *Lepidium* composition from a first process, combined with water (5-7 L per kg of first composition), is eluted through an RPLC column to apply the first composition to the column. The column is then eluted with an elution volume effective to elute a first effluent containing a first *Lepidium* composition, the solids component of which includes about 45% or more of a *Lepidium* polysaccharide component. Typically the elution volume contains aqueous solvent that is preferably water or an alcohol - water mixture having at least about 90 vol-% water and the elution volume amounts generally to 4 to 7, preferably 6, column volumes. The effluent is collected and concentrated to yield a first *Lepidium* composition having a *Lepidium* polysaccharide component of about 45% or more.

The first process can be further adapted to produce a second effluent by including, after elution of a first elution volume, the step of eluting a second elution volume that includes an aqueous solvent. Second *Lepidium* composition is obtained by concentrating the second effluent. In this or any other embodiment, the concentrating can be by any suitable means as know in the art such as evaporation, distillation, lyophilization, and the like. Generally, the second elution volume is typically to 4 to 10 column volumes. The second effluent contains a second *Lepidium* composition having between about 0.3% and about 12%, preferably between about 2% and about 10%, more preferably between about 5% and about 10% of benzyl isothiocyanate; between about 0.3% and about 2.7%, preferably between about 1% and about 2.5% of a *Lepidium* sterol fraction; and between about 10% to about 65%, preferably between about 10% and about 25% of a *Lepidium* fatty acid component.

In one embodiment of the adapted first process, the second elution volume has at least two gradient volumes, each of which contains an aqueous solvent. The identity or composition of the aqueous solvent in each of the two or more gradient volumes can be the same or it can be different. Preferably it is different. The second effluent resulting from the elution of the second elution volume can be fractionate collected into at least as many gradient fractions as there are gradient volumes eluted. The fractionate collected gradient fractions can be combined,

or they can be maintained separately. The gradient fractions can be concentrated to obtain second *Lepidium* compositions. It will be apparent to one skilled in the art that the identity and amounts of constituents of second *Lepidium* compositions made by this process can be varied by varying the number and composition of gradient volumes eluted, the number and volume of gradient fractions that are fractionate collected, and the manner in which gradient fractions are combined.

In a preferred embodiment of the adapted first process, the second elution volume is an alcohol - water mixture having 70 vol-% and preferably 80 vol-% or more alcohol, preferably SDA. The second *Lepidium* composition obtained in this process contains between about 0.2% and about 10%, preferably between about 2% and about 5%, of benzyl isothiocyanate; between about 0.15% and about 3%, preferably between about 0.2% and about 1%, of a *Lepidium* sterol component; between about 1% and about 65%, preferably between about 10% and about 25% of a *Lepidium* fatty acid component; and between about 0.3% and about 0.5% of a *macamide* component, wherein the *macamide* component comprises about 30% or more *macamide B* and 20% or more *macamide C*. Second *Lepidium* compositions typically have less than about 5%, preferably less than about 1%, of either a *Lepidium* polysaccharide component or a *Lepidium* amino acid component.

A second *Lepidium* composition can also be obtained from a second extraction composition from a second process. In a second process, residual *Lepidium* plant material that remains after separating the first extraction composition is contacted in a second contacting step with an aqueous solvent, preferably a mixture of an alcohol and water having about 80 vol-% or more, preferably about 90 vol-% or more alcohol, preferably SDA, to produce a second extraction composition or liquor. The process of contacting in the second contacting step can be the same as that in the first contacting step of a first process or it can be different. The liquor is separated from residual *Lepidium* plant material and concentrated to obtain a second *Lepidium* composition. The separating can be by any process known in the art; for example centrifugation, filtration, or decanting.

The second *Lepidium* composition obtained by a second process *(MD-A)* has between about 7% and about 9% of benzyl isothiocyanate, a *Lepidium* sterol component of between about 1% and about 3%, a *Lepidium* fatty acid component between about 10% and about 20%, and a *macamide* component of between about 0.3% and about 0.5%. Generally, a *Lepidium* sterol component includes about 50% or more β-sitosterol and also contains stigmasterol and campesterol. Generally, a *Lepidium* fatty acid component contains between

about 0.5% and about 1.2% 9,16-dioxo-10*E*,12*E*,14*E*-octadecatrieneoic acid between about 1.5% and about 3.5% of 16-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrieneoic acid between about 30% and about 35% linoleic acid, and between about 15% and about 22% linolenic acid. Generally, a *Lepidium* fatty acid component also contains oleic acid. In preferred embodiments, the second composition also contains about 0.2% or more of a *macamide* component, wherein the *macamide* component comprises 1% or less *macamide A*, about 10% or more *macamide B*, and about 20% or more *macamide C*.

The present invention also provides a third *Lepidium* composition that contains a mixture of a pharmaceutically acceptable excipient with a first *Lepidium* composition, a second *Lepidium* composition, or with both a first and second *Lepidium* composition. Pharmaceutically acceptable excipients are any materials that do not interfere with the pharmacological activity of the third composition or degrade the bodily functions of the animal to which it can be administered, but facilitate fabrication of dosage forms or actual administration of the composition; for example by improving palatability of oral dosage forms. Examples of pharmaceutically acceptable excipient include but are not limited to maltodextrin, calcium phosphate, and fused silica. Pharmaceutically acceptable excipients also include flavorants.

Third compositions of the present invention can be made, for example, by combining about 25% to about 50% (dry weight) of a first or second *Lepidium* composition of the present invention and about 75% to about 25% (dry weight) of one or more pharmaceutically acceptable excipients, combining this mixture with water (5 liter per kg of solids) and homogenizing the mixture. A Silverson Model 14 RT-A homogenizer (Silverson Corporation, East Longmeadow, MA) is an example of an apparatus suitable for carrying-out the homogenization. The homogenized composition is then dried to obtain a third *Lepidium* composition. The drying may be carried-out by any means as are known in the art; for example spray drying, oven drying, rotary vacuum drying, or lyophilization.

In yet other embodiments, the present invention provides novel amides of fatty acids, namely; N-benzyl octanamide (also called *macamide A* or MA-3) , racemic and enantiomerically pure N-benzyl-16-hydroxy-9-oxo-10*e*,12*e*,14*e*-octadecatrienamide (also called *macamide B* or MA-S-4), and N-benzyl 9,16-dioxo-10e,12e,14e-octadecatrienamide (also called *macamide C* or MA-9). All of these N-substituted amides are members of the class macamides, as that term is used herein. The N-benzyl amides of the present invention, which are useful in the prevention or treatment of carcinomas, can be synthetically prepared, or obtained from *Lepidium* plant material, preferably *Lepidium meyenii*, by chromatographic processes. The

chromatographic process is particular useful for obtaining enantiomerically pure N-benzyl-16(*S*)-hydroxy-9-oxo-10e,12e,14e-octadecatrienamide.

N-benzyl amides of the present invention can be synthetically prepared by various methods (*See* Barstaw, L.E. et al., J. Org. Chem., 36, 1305,(1971)). For example, N-benzyl amides of the present invention can be made by refluxing the corresponding carboxylic acid and benzyl amine with triphenylphosphene and bromotrichloromethane.

The N-benzyl amides of the present invention can be isolated from *Lepidium* plant material by c chromatographic process. Starting material for isolation of the N-benzyl amides of the present invention by chromatographic processes is a dry powder loading composition formed by mixing with silica gel (60 - 100 mesh) the residue from rotary vacuum concentration of an ethyl acetate extract of an aqueous suspension of a first *Lepidium* composition from a first process in which the aqueous solvent contains a mixture of about 75% SDA and about 25% water. The dry powder loading composition is applied to a chromatography column that is the eluted with a series of gradient volumes. The resulting gradient eluents are fractionate collected and compared by thin layer chromatography (TLC). Fractionate collected gradient eluents having similar TLC patterns are combined and combined fractions are further treated by column chromatography.

The methods of preventing or treating carcinomas, libido-related male sexual dysfunction, male impotence, and muscle fatigue comprise administering or dosing an effective amount of a composition, which can be a third *Lepidium* composition, that contains a first or second *Lepidium* composition, or both. The meaning of effective amount will be recognized by clinicians but includes an amount effective to either (1) reduce the symptoms of the disease or condition sought to be treated or prevented (i.e. cancer, sexual dysfunction), (2) induce a pharmacological change relevant to treating or preventing the disease sought to be treated or prevented, or (3) prevent the occurrence of the disease or condition.

The *Lepidium* compositions used in the method of the present invention can be administered by any route. Compositions of the present invention are administered alone, or are combined with a pharmaceutically-acceptable carrier or excipient according to standard pharmaceutical procedures. Preferably, *Lepidium* compositions are administered orally as a third *Lepidium* composition. For the oral mode of administration, the compositions of the present invention are used in the form of tablets, capsules, chewing gum, and the like. In the case of tablets, various disintegrants such as starch, and lubricating agents such as magnesium stearate and talc can be used.

Compositions of the invention can include pharmaceutically acceptable acid addition salts, particularly those obtained with mineral acids, for example hydrochloric or hydrobromic acid. However, organic acids, for example tartaric acid, can also be used.

The amount dosed will depend upon the composition used and the disease or condition to be treated or prevented. Generally, the compositions are dosed at between 0.1g and 10g per kg of body weight per day *(is this about right?)*.

The present invention is illustrated by the following non-limiting examples.

EXAMPLE 1

In this and other examples, HPLC analysis of Maca product were performed on a Hewlett Packard Series 1100 HPLC using an phenomenex, Luna C-8 column. GC/MS analysis of Maca product was performed on an HP-5973 MSD using a Supelco SAC-5 capillary column.

Roots of *Lepidium meyenii* (4.6 Kg) were cut to a nominal dimension of about 1 cm and contacted with an aqueous solvent (75 vol-% SDA and 25 vol-% water; 25 L per kg root) at 45°C by percolation. Decoction was separated from the plant material and concentrated to yield a first composition (2.1 Kg), denoted NE, having a solids content of 77% (i.e. 1.6 Kg on a dry basis). The solids component included, based on the solids present; 0.89% benzyl isothiocyanate, 0.079% of a *Lepidium* sterol component, 1.46% of a *Lepidium* fatty acid component, 8.72% of a *Lepidium* amino acid component, and 41.9% of a *Lepidium* polysaccharide component.

EXAMPLE 2

Roots of *Lepidium meyenii* (500g) were reduced in size to a nominal dimension of 0.5 cm and contacted with 14 L water by percolation. The aqueous phase was separated from residual plant material and evaporated to dryness to obtain 20g of a tacky product. The tacky product had a *Lepidium* sterol component of < 0.01%, a *Lepidium* fatty acid component of < 0.1%, a *Lepidium* amino acid component of 9%, and A *Lepidium* polysaccharide component of 44%.

EXAMPLE 3

The residual plant material from example 2 was contacted with 15 L of 100% SDA by percolation to form a liquor. The liquor was separated and concentrated to yield 10g of a second *Lepidium* composition having 7.8% benzyl isothiocyanate, a *Lepidium* sterol

component of 1.8%, a *Lepidium* fatty acid component of 22%, and a *macamide* component of 12%. No *Lepidium* amino acid component was found in the composition.

EXAMPLE 4

A first *Lepidium* composition (1.6 Kg) obtained according to the process of example 1 (i.e. NE), was slurried with water (8.8 L per kg of dry NE) for about 30 min. The slurry was applied to a RPLC column (15cm.x100cm packed with Amberlite® XAD-16 (Rohm and Haas Co.) that had been preconditioned with 20 column volumes of water. The column was eluted with a first elution volume (6 column volumes) of 100 vol-% water. The resulting first effluent was collected and evaporated to dryness to yield 1.5g of a first *Lepidium* composition having 0.15% benzyl isothiocyanate, 0.07% of a *Lepidium* sterol component, 1.8% of a *Lepidium* fatty acid component, 10% of a *Lepidium* amino acid component, and 48% of a *Lepidium* polysaccharide component. The composition had less than 1% of a macamide component.

EXAMPLE 5

The RPLC of example 4 was eluted with a second elution volume (6 column volumes) that was made-up of 100% SDA. The resulting effluent was collected and evaporated to dryness to yield 162g of a second *Lepidium* composition having 4.1% benzyl isothiocyanate, 0.4% of a *Lepidium* sterol component, 12% of a *Lepidium* fatty acid component, 4.4% of a *macamide* component, and no *Lepidium* amino acid component or *Lepidium* polysaccharide component.

EXAMPLE 6

A first *Lepidium* composition (1.6 Kg NE on a dry basis), obtained according to the method of example 1, was slurried with water (6.3 L per kg of first *Lepidium* composition) for about 30 min. The slurry was applied to a RPLC column (15cmx100cm) packed with Amberlite® XAD-16 resin (Rohm and Haas Co) that had been preconditioned with about 20 column volumes of water. The column was eluted with a first elution volume of 4 column volumes of water. The column was then eluted with a second elution volume that was made-up of five gradient volumes, each having a volume equal to 4 column volumes and each made-up of a mixture of SDA and water. The gradient fractions had, respectively, 20 vol-%, 40 vol-%, 60 vol-%, 80 vol-%, and 100 vol-% SDA. The gradient fractions corresponding to each of the gradient volumes were fractionate collected and analyzed (HPLC and GC). The gradient

fractions were free of both an *Lepidium* amino acid component and a *Lepidium* polysaccharide component. The gradient fractions contained other components as set-out below in Table 1.

Table 1. Content of Various *Lepidium* Components in Gradient fractions of a RPLC Process.

	Fr*. M-F1	Fr. M-F2	Fr. M-F3	Fr. M-F4	Fr. M-F5
Benzyl isothiocyanate - %	0.7	0.4	2.5	2.5	5.8
Lepidium sterol component - %	0.36	0.18	0.67	0.87	2.2
Lepidium fatty acid component - %	0.29	0.14	0.54	0.70	1.8
Macamide component - %	0	0	0.2	1.6	0

★ Fr. = fraction

The gradient fractions were combined and concentrated to yield 125g of a second *Lepidium* composition having 2.3% benzyl isothiocyanate, 0.8% of a *Lepidium* sterol component, 17.2% of a *Lepidium* fatty acid component, and 0.4% of a *macamide* component.

EXAMPLE 7

The tests were performed according to the MTT assay (*See*, Mosmann, T., J. Immun. Meth., 65, 55(1983).

Cells were planted in 96 well flat bottom plates with low evaporation lids. Three cell lines per plate were seeded in 0.2 ml medium per well. Each cell line was planted at the optimum concentration for its particular growth rate: HT-29 and A-549, 5000 c/ml; MCF-7, 15000 c/ml; A-498, 10,000 c/ml; PC-3, 15000 c/ml; and PACA-2, 10,000 c/ml. Products were tested at various dilutions (at least ten) to determine the ED_{50}.

The results are given in table 2

Table 2. 6-Cell Line Clinical Test Results, Expressed as ED^{50} values (in μg/ml)

Sample Code	Sample Description	Kidney A-498	Prostate PC-3	Pancreatic PACA-2	Lung A-549	Breast MCF-7	Colon HT-29
MA-1		24.88	85.77	17.66	28.66	>100	54.65
MA-2		9.08	4.05	3.06	17.97	29.33	22.97
MA-3 *macamide A*		5.83	6.42	4.33	7.57	28.45	19.02
MA-7		51.79	64.22	31.62	63.37	93.49	61.55
SY-197A	Maca NE	56.85	94.67	37.60	56.99	97.51	64.17
M-F1	Purified Product Fraction #1 (20% SDA)	>100	>100	>100	>100	>100	49.24
M-F2	Purified Product Fraction #2 (40% SDA)	>100	>100	>100	>100	>100	40.57
M-F3	Purified Product Fraction #3 (60% SDA)	>100	>100	>100	>100	>100	40.57
M-F4	Purified Product Fraction #4 (80% SDA)	38.29	29.59	29.43	17.03	34.41	6.10
M-F5	Purified Product Fraction #5 (100% SDA)	26.54	20.66	24.94	25.37	32.57	3.09
M-F2-5	Purified Product Fraction #2~5	>100	30.96	37.56	33.26	56.18	41.08
Adriamycin		3.59×10^{-3}	2.81×10^{-2}	5.22×10^{-3}	3.16×10^{-3}	1.07×10^{-1}	2.20×10^{-2}

EXAMPLE 8

Ten healthy rats were dosed by oral gavage with 5g of third *Lepidium* composition per kilogram of body weight. The animals were observed for signs of gross toxicity for 14 days. The body weights of the animals were checked on the 7th and 14th days. Body weight data is collected in Table 3. Gross necropsy findings at terminal sacrifice were unremarkable.

Table 3. Individual Bodyweight and Dosage.

Animal No.	Sex	Bodyweight (g)			Dose*
		Initial	Day 7	Day 14	
5025	M	246	309	349	1.6
5026	M	236	297	332	1.6
5027	M	251	340	383	1.7
5028	M	263	341	379	1.7
5029	M	242	308	335	1.6
5030	F	197	230	253	1.3
5031	F	200	231	261	1.3
5032	F	185	227	247	1.2
5033	F	193	230	250	1.3
5034	F	186	231	249	1.2

* Administered as a 60% w/w suspension in distilled water. Specific Gravity = 1.259 g/ml.

EXAMPLE 9

Sufficient mice (22 ± 1.5g) were dosed for 21 days with 1g of either of two third *Lepidium* compositions. One group (group I) was dosed with a third *Lepidium* composition made with a first *Lepidium* composition obtained according to example 1. A second group (group II) was dosed with a third *Lepidium* composition made with a second *Lepidium* composition obtained according to example 5. One hour after the dosing on the 21st day, each mouse was individually placed in water (25 ± 2°C) and observed. The elapsed time at which a mouse remained submerged. The results are collected in Table 4.

Table 4. Muscle Fatigue Results.

Group	Animal Number (n)	Duration of Swim Time In Seconds (mean ± SD)	p
Control Group	15	110.07 ± 2.58	
Group I	15	124.07 ± 3.30	<0.01
Group II	15	144.13 ± 3.52	<0.01

EXAMPLE 10

Sufficient male mice (22 ± 1.5g; 15 per group) were dosed by oral gavage for 21 days with 1 g/day of either of two third *Lepidium* compositions. Male mice in one group (group-I) were dosed with a third *Lepidium* composition made with a first *Lepidium* composition obtained according to example 1. Male mice in a second group (group II) were dosed with a third *Lepidium* composition made with a second *Lepidium* composition obtained according to example 5. A control group received no third *Lepidium* composition. Mice were ear-tagged or color coded for identification. On the 21st day, ½ hour after dosing, each male was placed in a cage with two mice and observed under darkroom conditions. The mice were observed for three hours and the number intromissions were recorded. Intromission was indicated by a characteristic rearward lunge by the male terminating coitus. Results are summarized in table 5 below.

Table 5. Intromission Results.

Group	Number of Intromissions (mean ± SD)	p
Control	16.33 ± 1.78	
Group I	46.67 ± 2.39	<0.01
Group II	67.01 ± 2.55	<0.01

EXAMPLE 11

Testectomies were performed on a sufficient number of male rats using pentobarbital, 45 mg/kg, as anesthetic. Rats were treated postoperatively for 3 days with sodium penicillin, 2,000 U/kg. Rats were ear-coded and color-coded for identification and divided into 7 groups. Three groups of 10 rats each (Set A) were dosed by oral gavage for 21 days with a third

Lepidium composition made with a first *Lepidium* composition obtained according to example 1. Rats in each of the three groups received a different dosage. A second set of three groups of 10 rats each (Set B) were dosed for 21 days with a third *Lepidium* composition made with a second *Lepidium* composition obtained according to example 5. Rats in each of the three groups received a different dosage. A control group of 10 rats received no third *Lepidium* composition.

On the 21st day, ½ hour after dosing, rats were restrained and an electric pulse of 20 V was applied to the penis using an electrode of a YSD-4G multifunction instrument. The time to achieve full erection was monitored. Results are collected in table 6 below.

Table 6. Incubation Period of Erection (IPE) in Testicle-Removed Rats with Oral Administration of M-PE and MC-A PE.

Group	Dose (mg/kg)	Animal Number (n)	Incubation Period of Erection in Seconds (mean ± SD)
Surgical Group		10	137.4 ± 81.6
Set A			
Low dose	45	10	121.4 ± 51.3
Middle dose	180	10	54.0 ± 25.8
High dose	1800	10	90.5 ± 80.2
Set B			
Low dose	45	10	71.2 ± 32.
Middle dose	180	10	73.2 ±39.
High dose	1800	10	80.9 ±85.1

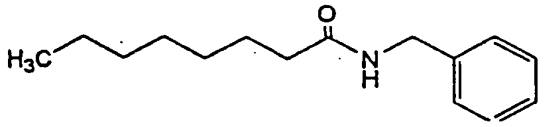
EXAMPLE 12

The N-benzyl amides of the present invention can be isolated from *Lepidium* plant material by chromatographic process. Starting material for isolation of the N-benzyl amides of the present invention by chromatographic processes is a dry powder loading composition formed by mixing with silica gel (60 - 100 mesh) the residue from rotary vacuum concentration of an ethyl acetate extract of an aqueous suspension of a first *Lepidium* composition from a first process in which the aqueous solvent contains a mixture of about 75% SDA and about 25% water. The dry powder loading composition is applied to a silica gel column (130 -270 mesh) and the column is then eluted with, in sequence, five elution volumes, each about 8 column volumes that contain mixtures of n-hexane and acetone in the following ratios (vol-% n-hexane:vol-% acetone): 10:1, 5:1, 2:1, 1:1, and 0:1. The column effluent is divided into 18 fractions. The 25th through 27th liter of effluent make-up a sixth fraction.. The

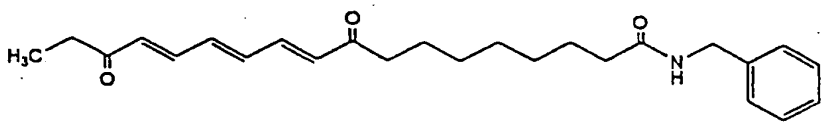
41st through 49½th liter of effluent make-up a ninth fraction. The 63rd through 70th liter of effluent make-up a twelfth fraction.

N-benzyl octanamide can be obtained by chromatographic treatment of the sixth fraction by treating the sixth fraction on a silica gel column using a n-hexane - acetone mobile phase (3:1). N-benzyl octanamide can be isolated from the effluent (*all of it? What part?*) by removing mobile phase from the effluent.

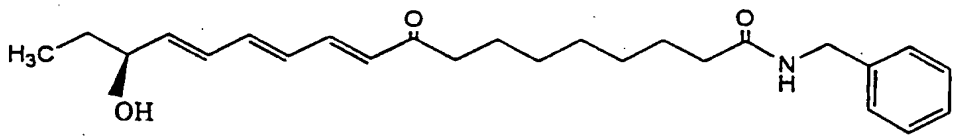
N-benzyl octanamide has the following physical and spectroscopic properties: white powder, m.p. = 76-78°C; UVλ_{max}(MeOH) = 213nm (ε = 11007). IR$_{\gamma KBr}$ (cm^{-1}): 3407, 2938, 2859, 1628, 1544, and 1451. Molecular Formula: $C_{15}H_{23}NO$. EI MS *m/z* [M$^+$]: 162, 149, 148, 106, 91, 77, and 57. ^{1}H and ^{13}C NMR ($CDCl_3$): 2.17 (2H, t, J=7.2 Hz, H-2), 1,59 (sH, m, H-3), 1.28 (8H, m, H-4, 4, 6, 7'), and 5.65 (1H, br s, NH). The structure of N-benzyl octanamide can be represented, without regard to stereochemistry, as:



N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatriene amide (MA-9, *macamide C*) can be isolated from the ninth fraction by further chromatographic treatment of the fraction on a silica gel column using 30 elution volumes of hexane/acetone as mobile phase. Fractions 15-20 (i.e. effluent from elution volumes 15-20) were further treated by preparative HPLC (Dynamax-60A column) using acetonitrile - water gradient eluent (5:95 to 95:5 vol. ratio, acetonitrile:water) to obtain N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrienamide. The structure of *macamide C* can be represented, without regard to stereochemistry, as:



N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrienamide has the following physical and spectroscopic properties: Light yellow powder, m.p. = 115-116°C; UVλ_{max}(MeOH) = 317nm (ε = 13847). IR$_{\gamma KBr}$ (cm$_{-1}$): 3297, 2930, 1715, 1680, 1637, 1602, 1544, 1112, and 1003. Molecular formula (elemental analysis): $C_{25}H_{33}NO_3$. EI MS *m/z*, 395; [M+]; 366, 338, 260, 163, 106, 91, and 77. The structure of *mamamide B* can be represented, without regard to stereochemistry, as:



N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrienamide (MA-S-4, *macamide B*) can be isolated from the twelfth fraction by preparative HPLC (Dynamax C-18 column) of the twelfth fraction using an acetonitrile - water gradient mobile phase (10:90 to 90:10 volume ratio acetonitrile:water).

N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrienamide has the following physical and spectroscopic properties: White powder, m.p. 95-96°C, UVλ_{max}(MeOH) = 314nm (ε = 36392). IR$_{\gamma KBr}$ (cm^{-1}): 3368, 2930, 2850, 1677, 1622, 1598, 1583, 1240, 1108, and 1057. Molecular formula (elemental analysis): $C_{25}H_{35}NO_3$. CI MS *m/z*, 397.

Experimental details are given below.

Contacting of *Lepidium meyenii* was carried out by percolation accordibg to the following procedure. The roots were grounded into pieces shorter than 3 cm in length. The ground material was then equally divided and loaded into three similarly-sized percolators. For the first cover, 75% SDA was loaded into each percolator at a ratio of 4.2:1 (volume of solvent in liter: weight of material in kg). After the solution had been circulated for 5 hr. at room temperature, the extract was transferred to a still and concentrated *in vacuo* at a temperature below 65 °C. For the second cover, fresh 75% SDA was added into percolator #1. After the solution had been circulated for 5hrs, the extract was transferred to percolator #2. After the solution in percolator #2 had been circulated for 5 hrs, the extract was transferred to percolator #3. The solution in percolator #3 was circulated for 5 hrs and the extract was transferred to the same still (for the first cover) and concentrated *in vacuo* at a temperature below 65°C. The procedure as described above was repeated three more times to give a total of 5 covers, which were concentrated until the residue had a total solid dry base of 72.9 %.

3.5 kg of the extract was suspended in 1.8 liter water, and extracted with EtOAc (3 × 1000 ml). The combined extract was concentrated *in vacuo* at 40°C to dryness (241 g). The residue was mixed with silica gel (60- 100 mesh, 200 g) and air-dried, and then applied to a silica gel column (7.5 x 60 cm, 800 g, 130-270 mesh) eluted with five 20 L hexane/acetone gradient volumes (10:1-5:1-2:1-1:1-0:1, total volume 100 l). Every 500 ml was fractionate collected and concentrated, a total of 200 portions were collected. All portions were analyzed by thin layer chromatography (TLC) and portions having similar TLC patterns were combined to

give 18 fractions. The sixth fraction (1.8 g from 25th through 27th liters collected) was chromatographed over silica gel (60 g) using hexane/acetone (3:1, 2 l) as the mobile phase to give 25 mg of N-benzyloctanamide (*macamide A* or MA-3). The ninth fraction (3.4 g; 41st through 49th liters collected) was initially separated over silica gel column (120 g, 130-270 mesh) into 30 fractions (100 ml each). The fractions (frs 15-20) which mainly contained N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrienamide (MA-9 or *macamide C*) were combined and subjected to preparative HPLC (column: Dynamax-60A C18, 2.14 I 25 cm i.d., 8 μm) using Acetonitrile/0.1% HOAc gradient system (0-60 min, from 5% Acetonitrile to 95 % Acetonitrile) as the mobile phase with a flow rate of 10 ml/min to give 10 mg of MA-9. The twelfth fraction (10 g) was chromatographed on silica gel eluting with $CHCl_3$/EtOAc (2:1, 200 ml per fraction, total 5 l). The fractions (10-15) mainly contained N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrienamide (MA-S-4 or *macamide B*) were combined and purified by preparative HPLC run on a Dynamax C-18 column using an acetonitrile/0.1% HOAc gradient system (0-60 min, from 10 % Acetonitrile to 90 % Acetonitrile) as eluent to give 33 mg of MA-S-4.

MA-3 showed the similar UV and IR spectra as those of N-benzyl-hexadecamide (MA-1) indicating that MA-3 was a fatty amide. The ^{13}C resonance of a carbonyl at δ 173.2 supported the amide structure. The ^{1}H signals at δ 4.41 (2H, d, J = 4.4 Hz), 5.71 (br s), 7.25 (5H), and ^{13}C signals at δ 127.5 (1C, d), 127.8 (2C, d), 128.7 (2C, d), and 43.6 (1C, t) suggested that MA-3 had a same amine group as that of MA-1. The molecular fromula, $C_{15}H_{23}NO$, was derived from the EI mass spectrum and indicated five degrees of unsaturation. The benzene ring and the amide group accounted for all the five unsaturation degrees. Therefore, the fatty acid moiety was acyclic.

The ^{1}H NMR spectrum displayed a terminal methyl group at δ 0.86, and the COSY spectrum revealed coupling of this group with an unresolved eight proton proton complex at δ 1.28. One methylene group was observed as triplet (J = 7.2 Hz) at δ 2.17, indicating that it was adjacent to the carbonyl group. In the COSY spectrum, this methylene group was found to be coupled to another methylene group at δ 1.59 which in turn was coupled to the methylene signals at *ca* δ 1.18. It was suggested that the fatty acid moiety had eight carbons. Treatment of this compound by 6N HCl followed by CH_2N_2 gave methyl caprylate that was identified by GC-MS analysis. Thus, the fatty acid moiety was unambiguously determined as octanoyl. Therefore, MA-3 was identified as N-benzyl-octanamide, also designated herein as *macamide A*.

Compound N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*,-octadecatrienamide (MA-S-4) showed maximum absorption at 314 nm (ε = 36392), suggesting a conjugated

trienone. It possessed a molecular formula $C_{25}H_{35}NO_3$ by mass spectrum and the NMR data (Table 1), which requires eight unsaturation equivalents. The ^1H signals at δ 4.73 (2H, d, J = 6 Hz), 9.00 (br s, NH), 7.35 (5H), and ^{13}C signals at δ 127.3 (1C, d), 128.1 (2C, d), 128.9 (2C, d), and 43.4 (1C, t) suggested that MA-S-4 had the same amine group as that of MA-1 and MA-3. The ^{13}C NMR spectrum revealed two carbonyl, a benzene ring and three other olefins, accounting for all the degrees of unsaturation and indicating MA-S-4 had an acyclic fatty acid moiety. The DEPT and ^{13}C NMR spectra showed the signals for total eighteen carbons, including one methyl, eight methylenes, seven methines, two quaternary carbons for the fatty acid moiety. Thus, a C_{18} fatty acid moiety was proposed.

The COSY, with aid of TOSCY, assigned the all proton resonances. The isolated terminal methyl group at δ 1.07 (H-18) and methylene groups at δ 2.45 (H-2) and 2.54 (H-8) were chosen as the starting points for the analysis of COSY and TOCSY. The correlations between H-18 (δ 1.07) and H-17 (δ 1.74), H-17 and H-16 (δ 4.41), H-16 and H-15 (δ 6.25), H-15 and H-14 (δ 6.71), H-14 and H-13 (6.82), H-13 and H-12 (δ 6.44), H-12 and H-11 (δ 7.47), H-11 and H-10 (δ 6.33) led to the assignment of the protons continuing from H-18 to H-10. The correlations between H-2 and H-3 (δ 1.63), H-3 and H-4 (δ 1.24), H-8 and H-7 (δ 1.83), H-7 and H-6 (δ 1.34) led to the assignment of protons from H-2 to H-8 except for H-5. The overlaped proton systems at (δ 1.24) contained four protons. Hence, two protons were assigned to H-5 (δ 1.24). In HMBC spectrum, the long-range correlations between H-2 (δ 2.45) and C-1 (δ 173.1), and H-8 (2.54) and C-9 (δ 200.0) confirmed the assignment of H-2 and H-8. The ^{13}C NMR data were then assigned by HSQC spectrum. The ^{13}C resonance of C-16 at δ 72.7 indicated that one hydroxy group was attached to C-16.

The large couplings between the olefinic protons ($J_{10,11}$ = 15.6 Hz, $J_{12,13}$ =14.0 Hz, and $J_{14,15}$ = 15.6 Hz) revealed that three of the double bonds had *E* configurations. The absolute stereochemistry of C-16 secondary alcohol was determined by optical rotations which were of the same sign and magnitude ($[\alpha]_D$ +) as those of coalital ($[\alpha]_D$ +21°, *C* = 0.63, Me_2CO) and 16(S)-hydroxy-9-oxo-10*E*,12*E*,14*E*,-octadecatrienoic acid ($[\alpha]_D$ + 11.7°, *C* = 0.2, Me_2CO), assigning a *S* configuration to C-16. The stereochemistry of coalital was determined by exciton chirality method reported by Bernart et al., J. Nat. Prod. 56:245(1993)).

Therefore, MA-S-4 was determined to be *N*-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrienamide.

Compound N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrienamide (MA-9) was isolated as a light yellow powder, m.p. 115-6°C. The UV spectrum showed maximum absorption at 317 nm (ε = 13847), suggesting a conjugated trienone. The strong absorption bands at 2950 (aliphatic), 1715, 1680 (conjugated ketone), 3297, 1640, 1545 (amide), and 1003 cm^{-1} (*trans* double bond) in the IR spectrum indicated that this compound was a fatty amide. The EI mass spectrum of MA-9 showed a molecular ion peak at *m/z* 395 consistent with the molecular formula $C_{25}H_{33}NO_3$. The ^{13}C resonance of the carbonyl carbon at δ 173.3 favored that MA-9 was a fatty amide.

The ^{1}H signals at δ 4.62 (2H, d, J = 4.4 Hz), 8.83 (br s), 7.30 (5H), and ^{13}C signals at δ 127.6 (1C, d), 128.4 (2C, d), 129.2 (2C, d), and 43.6 (1C, t) suggested that MA-9 had a same amine group as those of MA-1, MA-3 and MA-S-4. The intense fragment ion peaks at m/z 91 and 106 supported the above inference.

All proton and carbon signals of the fatty acid moiety were unambiguously assigned using COSY, TOCSY, HMQC and HMBC techniques. The isolated terminal methyl group at δ 1.01 (H-18), methylene groups at δ 2.38 (H-2) and 2.50 (H-8), and olefinic protons for H-10 at δ 6.30 and H-15 at δ 6.34 were chosen as the starting points for the analysis of COSY and TOCSY. The methyl group (Me-18) were coupled with H-17 (δ 2.61). The correlations between H-2 (δ 2.38) and H-3 (δ 1.62), H-8 (δ 2.50) and H-7 (δ 1.23) were observed. The correlations between H-3 and H-4 (δ 1.19), H-7 and H-6 (δ 1.19) were observed. The proton complex at δ 1.19 had six protons. The H-5 signals were regarded to account the left two protons. The correlations between H-10 (δ 6.30) and H-11 (δ 7.30), H-15 (δ 6.34) and H-14 (δ 7.30), H-11 and H-12 (δ 6.68), H-14 and H-13 (δ 6.68) confirmed the triene structure.

In HMBC, the correlations between H-2 (δ 2.33) and C-1 (δ 173.3), H-8 (δ 2.56) and one ketone (C-9, δ 200.5) confirmed the assignment of H-2 and H-8. The correlation between H-17 (δ 2.61) and another ketone (C-16, δ 200.3) confirmed the position of another ketone at C-16. The positions of the two ketone groups were supported by the daughter ion peaks observed in the EI mass spectrum. The ions at *m/z* 366 and 338 derived from the cleavage of C-17-C16 bond, and C-16-C-15 bond, respectively, indicated that a ketone was located at C-16. The ions at *m/z* 135, 163 and 260 derived from the rupture of C-9-C-10 bond and C-8-C-9 bond, respectively, revealed another ketone at C-9.

The double bonds at C-10 and C-14 were determined to be *E* configurations based on the large coupling constants ($J_{10,11}$ = 15.3 Hz, and $J_{15,14}$ = 15.3 Hz). Because the

multiplets of H-11, H-12, H-13 and H-14 are not first order, and may be AA'BB' system, they do not display substantive couplings each other. The configuration of the double bond at C-12 could not be determined by coupling constant. However, it might be suggested to be *E* configuration based on the inference that MA-9 be a oxidized product of MA-S-4.

Therefore, MA-9 was determined to be *N*-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadecatrienamide. MA-9 is a new compound and named *macamide C*.

What is claimed is:

1. An isolated *Lepidium*-derived composition, essentially free of cellulosic material comprising about 40% or more of a *Lepidium* polysaccharide component.

2. The composition of claim 1 further comprising an aqueous component.

3. The composition of claim 1 further comprising about 8% or more of a *Lepidium* amino acid component.

4. The composition of claim 3 wherein the *Lepidium* amino acid component comprises at least about 70% proline, at least about 5% glutamic acid, and at least about 5% valine.

5. The composition of claim 3 further comprising up to about 0.3% benzyl isothiocyanate and up to about 0.5% macamide component.

6. The composition of claim 1 comprising about 45% or more of a *Lepidium* polysaccharide component.

7. The composition of any one of claims 1 to 6 additionally comprising at least one pharmaceutically acceptable excipient.

8. An isolated *Lepidium*-derived composition comprising:

a) about 0.3% or more of benzyl isothiocyanate,

b) about 0.15% or more *Lepidium* sterol component,

c) about 1% or more *Lepidium* fatty acid component, and

d) about 0.3% or more of macamide component.

9. The composition of claim 8 comprising:

a) between about 2% and about 5% benzyl isothiocyanate,

b) between about 0.2% and about 1% *Lepidium* sterol component,

c) between about 10% about and about 20% *Lepidium* fatty acid component, and

d) between about 3% and about 7% of macamide component.

10. The composition of claim 9 comprising:

a) between about 5% and about 9% of benzyl isothiocyanate,

b) between about 1% and about 3% of *Lepidium* sterol component,

c) between about 20% and about 30% of *Lepidium* fatty acid component, and

d) about 10% or more of macamide component.

11. The composition of any of claims 8-10 additionally comprising at least one pharmaceutically acceptable excipient.

12. N-benzyl octanamide having the chemical formula $C_{15}H_{23}NO$.

13. N-benzyl-16(*R,S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrieneamide having chemical formula $C_{25}H_{35}NO_3$.

14. N-benzyl-16(*S*)-hydroxy-9-oxo-10*E*,12*E*,14*E*-octadecatrieneamide having the chemical formula $C_{25}H_{35}NO_3$.

15. N-benzyl-9,16-dioxo-10*E*,12*E*,14*E*-octadectrienamide having the chemical formula $C_{25}H_{33}NO_3$.

16. A process for obtaining a the composition of claim 2 comprising the steps of:

a) contacting *Lepidium* plant material with an aqueous solvent, and

b) separating the contacted aqueous solvent from the *Lepidium* plant material to obtain the composition of claim 2.

17. The process of claim 16 further comprising the step of:

c) concentrating the composition of step b) to isolate the composition of claim 1.

18. The process of claim 17 wherein the aqueous solvent is water and wherein the composition is the composition of claim 3.

19. The process of claim 17 wherein the aqueous solvent is a mixture of an alcohol and water and wherein the composition is the composition of claim 5.

20. The process of claim 19 wherein the alcohol is SDA.

21. The process of claim 20 wherein the aqueous solvent comprises a mixture of 75 vol-% SDA and 25 vol-% water.

22. The process of claim 19 further comprising the steps of:

d) applying the first *Lepidium* composition from step c) to a reverse phase liquid chromatography column, and

f) eluting the reverse phase chromatography column with a first elution volume of aqueous solvent effective to elute a first effluent from which the composition according to claim 6 is isolated.

23. The process of claim 22 wherein the composition is isolated by concentrating the first elution volume.

24. The process of claim 22 further comprising the steps of:

g) eluting the reverse phase chromatography column with a second elution volume of aqueous solvent to form a second effluent from which the composition of claim 9 is isolated.

25. The process of claim 24, further comprising the step of:

h) concentrating the second effluent of step g) to isolate the composition of claim 9.

26. The process of claim 24 wherein the second elution volume comprises about 80 vol-% alcohol or more.

27. The process of claim 24 wherein the second elution volume is effective to elute the composition of claim 9 and comprises two or more sequentially eluted gradient volumes, each effective to elute a composition according to claim 8, wherein the resulting second effluent is fractionate collected to obtain at least one gradient fraction for each one of the two or more gradient volumes; and wherein the gradient fractions are combined and concentrated to obtain the composition of claim 9.

28. The process of claim 27 wherein each of the two or more gradient volumes comprises a mixture of an alcohol and water and wherein the vol-% alcohol in the first gradient volume is about 20 vol-% or more and the vol-% alcohol in any subsequent gradient volume is equal to or greater than the vol-% alcohol in the immediately previously eluted gradient volume.

29. The process of claim 16 wherein the *Lepidium* plant material is from *Lepidium meyenii*

30. A process for producing the composition of claim 10 comprising the steps of:

a) contacting *Lepidium* plant material with an aqueous solvent comprising about 90 vol-% or more water,

b) concentrating the contacted aqueous solvent to make a residue of *Lepidium* plant material,

c) contacting the residue of *Lepidium* plant material with aqueous solvent comprising a mixture of an alcohol and water having about 90 vol-% alcohol or more to form a liquor, and

d) concentrating the liquor to obtain the comopositin - -laim 10.

31. The process of claim 30 wherein the *Lepidium* plant materia[illegible] *enii*.

32. The process of claim 31 wherein the alcohol is SDA.

33. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of a composition of cla[illegible] 1 to an animal.

34. The method of claim 33 wherein the animal is a human.

35. A method of treating or preventing cancer in an animal comp[illegible]g administering a cancer treating or preventing effective amount effective amount of the composition of claim 5 to an animal.

36. The method of claim 35 wherein the animal is a human.

37. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of the composition of claim 6 to an animal.

38. The method of claim 37 wherein the animal is a human.

39. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of the composition of claim 8 to an animal.

40. The method of claim 39 wherein the animal is a human.

41. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of the composition of claim 9 to an animal.

42. The method of claim 41 wherein the animal is a human.

43. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of the composition of claim 10 to an animal.

44. The method of claim 43 wherein the animal is a human.

45. A method of treating or preventing cancer in an animal comprising administering a cancer treating or preventing effective amount of a composition of claim 7 to an animal.

46. The method of claim 45 wherein the animal is a human.

47. A method of treating or preventing sexual dysfunction a comprising administering an sexual dysfunction treating or preventing effective amount of a *Lepidium* composition of any of claims 1, 5, 6, 8, 9, or 10 to an animal suffering from sexual dysfunction.

48. The method of claim 47 wherein the animal is a male animal and the sexual dysfunction is a sub-normal libido.

49. The method of claim 47 wherein the animal is a male animal and the sexual dysfunction is impotence.

50. The method of claim 47 wherein the animal is female and the sexual dysfunction is sub-normal fertility.

51. A method of treating or preventing sexual dysfunction a comprising administering an sexual dysfunction treating or preventing effective amount of a *Lepidium* composition of claim 7 to an animal suffering from sexual dysfunction.

52. The method of claim 51 wherein the animal is a male animal and the sexual dysfunction is a sub-normal libido.

53. The method of claim 51 wherein the animal is a male animal and the sexual dysfunction is impotence.

54. The method of claim 51 wherein the animal is female and the sexual dysfunction is sub-normal fertility.